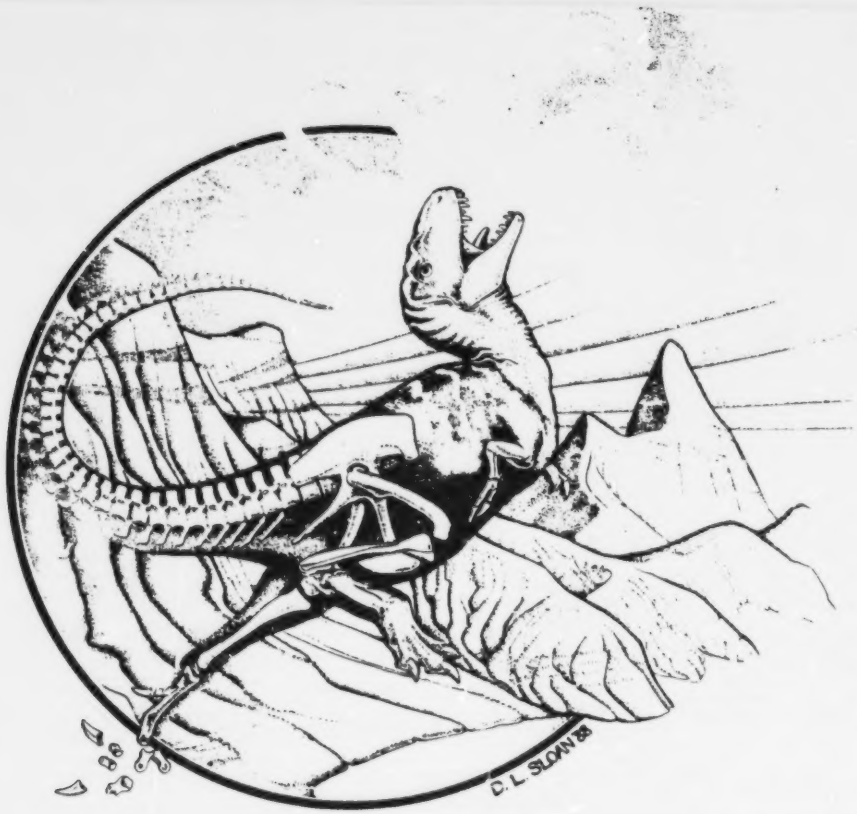

Society of Vertebrate Paleontology

48th Annual Meeting

FIELD TRIP "C" (October 16, 1988)

PALEONTOLOGY AND GEOLOGY OF THE EDMONTON GROUP (LATE CRETACEOUS TO EARLY PALAEOCENE), RED DEER RIVER VALLEY, ALBERTA, CANADA

Edited by: Dennis Braman

OCCASIONAL PAPER OF THE TYRRELL MUSEUM OF PALAEONTOLOGY, #8

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Alberta
CULTURE AND MULTICULTURALISM

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SOCIETY OF VERTEBRATE PALEONTOLOGY 48th ANNUAL MEETINGS

FIELD TRIP C

Prepared by D.R. Braman and D. Eberth

Field Trip to view portions of the Edmonton Group along the Red Deer River Valley. Leaders: Loris Russell, Philip Currie and Dennis Braman. Logistical arrangements:

All expenses are included in registration fee and include vehicle transport, box lunch, beverages in field and field guide.

Schedule:

Vehicle will leave at 8:00 a.m. from Drumheller Inn and follow the Dinosaur Trail to Horsethief Canyon where the lower Horseshoe Canyon and the Drumheller Marine Tongue will be viewed. The quarry of the holotype of Edmontosaurus regalis will also be visited.

11:30 a.m. Party will drive to the Tolman Bridge area along highways 10, 9, 56, and 585 where a lunch stop will be made. This site provides an overview of the Horseshoe Canyon Formation. The site of Brown's Hypacrosaurus paratype will also be visited.

1:00 p.m. Party will drive to the Knudson's Farm Locality where Upper Horseshoe Canyon, Whitemud, Battle and Scollard formations are exposed.

3:30 or 4:00 p.m. Start of drive back to Drumheller arriving at approximately 5:00 p.m.

Notes:

1. In the event of inclement weather, the trip will have to be modified somewhat because wet weather causes slippery slopes that are unmanageable.

2. The majority of the field trip will be away from civilization, so purchase of such items as film should be made before the start of the field trip.

We hope you have an enjoyable field trip.

EDMONTON GROUP FIELD TRIP

The Edmonton Group as defined by Gibson (1977) records the persistent though punctuated eastward progradation of a molasse wedge derived from the newly arising Rocky Mountains, and the withdrawal of the 'Bearpaw Sea' from southern Alberta. The age of the Edmonton Group is fairly uniform throughout southern Alberta, ranging from latest Campanian at its base through Maastrichtian and earliest Palaeocene at its top (Fig. 2). Edmonton Group lithofacies comprise fossiliferous interbedded sandstones, siltstones, claystones, coal and a variety of diagenetic products (ironstone and smectite clays). In the Red Deer River valley, the unit is about 350-400 m thick, thins to the east, conformably overlies the Bearpaw Formation, and is conformably overlain by the Palaeocene age Paskapoo Formation. Cretaceous/Tertiary boundary sequences are preserved in some outcrops.

The Edmonton Group consists of four formations: in ascending order, the Horseshoe Canyon, Whitemud, Battle, and Scollard formations (Gibson, 1977). The Horseshoe Canyon Formation makes up in thickness 2/3 of the entire Edmonton Group in the Red Deer River valley and can be divided into four informal units that reflect gradational facies changes related to delta and coastal plain progradation punctuated by sudden marine transgressions. The Whitemud and Battle formations together comprise approximately 15 m of section in the Red Deer River valley and represent a time of (relatively) reduced clastic sedimentation, high subsidence and extreme volcanic activity. The Scollard Formation marks a return to "normal" progradation such as that initiated during deposition of the Horseshoe Canyon Formation.

During this one day field trip only sites of major palaeoecological/ stratigraphic interest will be visited. These include 1) the lower part of the Horseshoe Canyon Formation and the Drumheller Marine Tongue exposed at Horsethief Canyon, 2) the uppermost portion of the Horseshoe Canyon Formation at Tolman Bridge north-northwest of Drumheller, and 3) a Cretaceous/Tertiary boundary sequence at Knudson's Farm north-northwest of Drumheller.

THE HORSESHOE CANYON FORMATION

The Horseshoe Canyon Formation is about 250 m thick in the Red Deer River valley. However, the full stratigraphic extent of the formation is nowhere completely exposed. The Horseshoe Canyon Formation has received a great deal of attention from stratigraphic and economic geologists due to its coal seams, which were the basis of a boom economy in the first half of this century.

The rocks comprising the formation are for the most part flat-lying interbedded silty sandstones, siltstones, claystones and carbonaceous shales, coals, and diagenetic ironstones and altered volcanic ashes. Twelve separate coal seams occur throughout the sequence and provide a reliable means for correlating discontinuous exposures over relatively short distances in the Red Deer River valley. Attempts at regional correlation of coal seams have proved unreliable (Hughes, 1984). The Horseshoe Canyon Formation can be divided into four informal packages representing discrete facies associations that interdigitate, grade, or pass abruptly from one to another.

PACKAGE 1: TIDE-DOMINATED ESTUARINE/COASTAL-MARGIN ENVIRONMENTS

The lower 40 m of the Horseshoe Canyon Formation comprises a complex interbedded sequence of estuarine to tidal channel, barrier/back barrier, lagoonal, and tidal mudflat facies deposited along the western margin of the

'Bearpaw Sea' and exposed along the Red Deer River valley 20 km southeast of Drumheller. Rahmani and Hills (1982) studied a 12 km stretch of this package near the village of East Coulee (Fig. 1) and concluded that it comprises an overall prograding coastal-margin environment punctuated by at least three marine transgressions. In at least one horizon, a transgressive interval consisting of marine shale and bioturbated sandstone is preserved. In his interpretation, the three lowest coal seams (coals 0, 1, and 2) reflect lagoonal peat-forming environments that were deposited behind prograding barrier sandstones. The upper eroded surfaces of the coal seams mark the onset of the transgressive events. The causes of the sudden transgressions are unclear but probably involve a combination of basinal, extrabasinal, and possibly eustatic processes.

Altered (bentonic) volcanic ash horizons are present locally within the coaly horizons.

Local occurrences of fossil "forests" comprising in-situ silicified conifer stumps and root systems are found associated with the coal seams. Toredo bored wood has been recovered from this unit (Bromley et al 1984).

In addition to the extensively occurring barrier island, tidal and estuarine channel facies, local oyster bar facies (oriented SW-NE and thus parallel to palaeoshore) are present. Up to four meters thick, these units are resistant, well cemented, and locally glauconitic. In-place as well as abraded/broken accumulations are locally present. Many shells possess borings.

Invertebrate trace fossils are common. Vertebrate fossils are rare in this unit, and no dinosaur skeletons have been found. Shark teeth and fish bones are sometimes found in local pockets.

PACKAGE 2: DELTA PLAIN TO ALLUVIAL PLAIN ENVIRONMENTS

The tidally dominated estuarine to coastal margin succession of Package 1 passes upwards gradationally into a delta plain succession dominated by meandering channel, levee, crevasse channel and splay, interchannel bay-fill facies as well as a variety of coal forming environments related to channel proximity (Waheed, 1983). The presence of occasional marine palynomorphs in the bay-fill facies and the occurrence of proximal-to-channel coals indicate continued periodic marine inundations probably related to avulsion and local subsidence. This succession passes up into a thick alluvial plain succession dominated by meandering channel, levee, crevasse channel and splay, floodbasin, oxbow-fill, and distal floodbasin-coal facies.

In all, Package 2 is 145 meters thick. Coal seams are less numerous and continuous than in Package 1 and the remains of dinosaurs (skeletons, bonbeds) are more common. Package 2 is best represented by the exposures surrounding the Tyrrell Museum of Palaeontology.

PACKAGE 3: DRUMHELLER MARINE TONGUE

The Drumheller Marine Tongue is a locally occurring, 5 m thick zone of pelecypod bearing (Ostrea and Corbicula), iron-stained sandstones and siltstones with locally abundant terrestrial plant remains, representing marine transgression and possibly storm surge events. In-situ, as well as abraded, shell horizons are present. The Drumheller Marine Tongue is best viewed at Horsethief Canyon northwest of the Tyrrell Museum on Highway 576 or in the lowest exposures of Horseshoe Canyon located 20 km southwest of Drumheller on Highway 9.

PACKAGE 4: ALLUVIAL PLAIN ENVIRONMENT

The remaining 60 m of the Horseshoe Canyon Formation which produces dinosaur and other vertebrate fossils, has received no formal attention from

sedimentologists but appears to be an alluvial plain succession dominated by meandering to vertically accreted channel, levee, crevasse splay, and floodbasin facies. Coals are relatively rare occurring only near the top of the succession. Coal distribution appears to reflect variation in rates of sediment input and/or basin subsidence rather than climatic variation. Exposures of Package 4 will be visible at our lunch stop at the Tolman Bridge and at our final stop, Knudson's Farm.

The exposed section at the Knudson's Farm locality (Fig. 3) is a nearly complete sequence spanning the interval from upper Horseshoe Canyon Formation, through the Whitemud and Battle Formations, terminating in the Scollard Formation fairly close to but below the Ardley coal seam. This interval includes upper Maastrichtian through to lower Palaeocene strata with the Cretaceous-Tertiary boundary being precisely determined by use of geochemistry, magnostratigraphy and palynomorphs. As a result, it is a well exposed, well documented and well studied section.

The Horseshoe Canyon Formation exposed here consists of about 130 m of strata. It is light grey weathering, fine-grained sandstone with well-developed microscale crossbedding, and greenish-grey weathering mudstone to siltstone in the lower portion of the section. Carbonaceous and coal-bearing interbeds are conspicuously rare. The nature of the sediments and structures indicate alluvial plain depositional environments predominated. Between coal seam 11 (Carbon seam) and the Whitemud contact the amount of carbonaceous and coal bearing units are abundant. Both coal seam 11 and 12 (Thompson seam) are relatively thick and laterally extensive in the region. The sandstone units associated with this organic rich interval are thick, poorly sorted, commonly crossbedded and at times coarse grained. Again, the sandstones are fluvial in origin.

The age of this portion of the sequence is Maastrichtian. Srivastava (1970) equated the upper Horseshoe Canyon Formation to the Mancicorpus vancampai and Scollardia trapaformis palynomorph zones and provided lists of diagnostic taxa occurring within these zones. The assemblages are diverse and abundant. Megafloras are only poorly known from the interval.

It is the vertebrate faunas, especially the dinosaurs, that are the best known fossils from the Horseshoe Canyon Formation. Some of the earliest finds of significant dinosaur remains in Alberta were made along the Red Deer River north-west of Drumheller. More than a hundred complete or partial skeletons have been excavated from exposures of the Horseshoe Canyon Formation. The remains are probably as abundant as in Dinosaur Provincial Park, but are limited by the more vertical nature of the exposures.

The following dinosaurs are presently known from this formation:

Dromaeosauridae:	cf. Dromaeosaurus sp.
	Saurornitholestes sp.
Troodontidae:	Troodon sp.
Elimisauridae:	Chirostenotes sp.
Ornithomimidae:	Dromiceiomimus Brevitertius
	Ornithomimus Edmontonicus
	Struthiomimus cf. Altus
Tyrannosauridae:	Albertosaurus Sarcophagus
	Daspletosaurus cf. Tolosus
	Aublysodon sp.
Hypsilophodonotidae:	Parksosaurus Warreni
Hadrosauridae:	Edmontosaurus Regalis
	Hypacrosaurus Altispinus
	Saurolophus Osborni

Pachycephalosauridae:	Stegoceras Edmontonense
Nodosauridae:	Edmontonia Longiceps
Ankylosaurae:	Euoplocephalus Tutus
Ceratopsidae:	Anchiceratops Ornatus
	Arrhinoceratops Brachyops
	Pachyrhinosaurus cf. Canadensis

There is some overlap of genera with the Judith River Formation of Dinosaur Provincial Park. The differences can be accounted for by the younger age of the Horseshoe Canyon Formation, and by differences in the environments. The dinosaurs of the Horseshoe Canyon Formation were living closer to the sea than those of Dinosaur Provincial Park, and the habitats were lower and wetter.

Since the establishment of the Tyrrell Museum of Palaeontology in Drumheller, the rate of discovery and recovery of fossils in the Horseshoe Canyon Formation has increased dramatically. Over the next decade, the number of genera known should greatly increase as skeletons, isolated bones, bonebeds and microsites receive the same sort of attention that has been given these resources in Dinosaur Provincial Park in the past.

A large number of other vertebrate types have been recovered from the Horseshoe Canyon Formation although none of they are known in great detail. The following is a list of the main components of this faunal assemblage.

Condrichthyes

Myledaphus bipartitus Cope

Lamna sp.

Osteichthyes

Acipenser sp.

Kindlea fragosa (Jordon)

Atractosteus sp.

Belonostomus sp.

Palaeopsephurus sp.

Amphibia

Urodela, undet. gen. and sp.*

Anura, undet. gen. and sp.*

Reptilia

Aspideretes sp.

Basilemys sp.

Leurospondylus ultimus Brown

Champsosaurus albertensis Parks

Leidyosuchus sp.

Albertochampsa sp.

Mammalia

Didelphodon coyi

Multituberculates

WHITEMUD FORMATION

The Whitemud Formation consists of light grey to white-weathering bentonitic sandstone, siltstone and claystone. The white color comes from grain coatings and pore fillings of kaolin and/or montmorillonite. The sediment represents deposition as part of a large delta plain complex under conditions of declining sediment input rates and increasing outfall of

volcanic ash. No fossils are know from the unit in the Red Deer River area but in southern Saskatchewan both plant and mollusc fossils are known. The lower contact with the Horseshoe Canyon Formation is abrupt to gradational while the upper contact with the Battle Formation is generally abrupt but conformable. The upper 12 to 48 cm contains stem-like tubes and vertical fractures filled with dark black bentonitic shale. The thickness is 3.5 m at this particular site. (Irish and Havard, 1968; Gibson, 1977).

BATTLE FORMATION

The Battle Formation consists of mauve-grey weathering, dark grey to black or purplish black bentonitic shale. The unit is about 8 m thick and contains within it one to three white weathering beds referred to as the Kneehills Tuff dated at 66 mybp (Folinsbee et al., 1961). Its deposition is thought to be in standing bodies of water with a large amount of volcanic ash being contributed to the environment. It appears to represent the zenith of low sediment input-high volcanic activity conditions. The Battle is noted for its lack of fossils. No megafossils have been found. Microfossils such as algal remains, megaspores (silicified), bone fragments, teeth, ostracods?, carbonized wood fragments and foraminifera are known to occur in the unit. The upper contact with the Scollard Formation has been described as unconformable (Russell, 1983) and conformable (Gibson, 1977). (Irish and Havard, 1968; Gibson, 1977).

SCOLLARD FORMATION

The Scollard Formation (approximately 80 m thick) consists of silty sandstones, mudstones, coals, ironstones and altered volcanic ashes all of which appear to have been deposited in an alluvial to delta plain setting. Coals are abundant in the the upper 1/2 of the formation.

The Scollard Formation at Knudson's farm consists of approximately 55 m (180 feet) of strata similar in appearance and general composition to the upper part of the Horseshoe Canyon Formation. The Scollard Formation includes two coals, the Nevis (coal seam #13) and the Ardley (coal seam #14). The latter is not exposed at the locality but must occur just above the top of the exposed section.

The Scollard Formation is well known for its vertebrates particularily the dinosaurs occurring in the lower portion and the mammals from the upper portion.

Dinosaurian remains were first collected from the Cretaceous part of the Scollard Formation in September 1910 when a party led by Barnum Brown of the American Museum of Natural History in New York excavated the type of Leptoceratops gracilis. Several other specimens were recovered by the expedition as it slowly passed down the Red Deer River by boat, prospecting both banks as it went. Charles M. Sternberg, of the National Museum of Natural Sciences (then part of the Geological Survey of Canada), working upriver from Drumheller, collected a skeleton of Thescelosaurus neglectus from this unit in 1925. The distinctiveness of its dinosaurian fauna, however, remained unrecognized. In the course of his studies of fossil leaf assemblages from Cretaceous and Palaeocene strata in Alberta, in October of 1945 Walter Bell (then Chief of the Palaeontological Section of the Geological Survey of Canada) in a memo asked Sternberg what the upper limit of dinosaurian occurrences was in the Edmonton Group, and suggested that any material from above the Kneehills Tuff might be of Lancian, or terminal Cretaceous age. During the summers of 1946 and 1947 Sternberg demonstrated the presence of the Triceratops fauna in these strata, and thus their equivalence in age to Lancian sediments to the south (Sternberg 1947, 1949).

The dinosaurian assemblage from the lower part of the Scollard Formation (see Table 1) constitutes the most northerly known occurrence of the Lancian Triceratops fauna. The number of articulated specimens taken from the unit is small (14), but so also is the surface area of exposures from which they were recovered (about 3 square kilometers according to aerial photographs). The number of articulated specimens collected per square kilometre (about 4.7) compares favourably with the ratio from older (Campanian) sediments in Dinosaur Provincial Park (about 309, Beland and Russell 1978). There are indications of distinct litho and faunal facies as well. Triceratops specimens seem to be larger, on the average, than those from the Hell Creek local fauna, which are in turn larger than those from the Lance Creek (Wyoming) local fauna further south. Hadrosaurs are represented only by tooth fragments in The Henry Farm locality (Russell, 1987). The small herbivorous protoceratopsid Leptoceratops (weight about 100 kg) replaces the small bipedal herbivorous ornithopod Thescelosaurus (weight about 300 kg) in relative abundance. The giant armoured dinosaur Ankylosaurus appears to have been unusually abundant, for only one articulated specimen of this form has been collected from Lancian-age strata elsewhere in the interior of North America. A Tyrannosaurus rex skeleton collected on the Knudson's Ranch about 10m below the K-T boundary is currently on display at the Tyrrell Museum. The presence of additional taxa of dinosaurs including a possibly iguanodont is indicated by teeth and other small material collected by Loris S. Russell of the Royal Ontario Museum (Russell, 1987).

The dinosaurian assemblage from the Scollard Formation also assumes a special importance because of its proximity to basal Palaeocene strata and the controversy surrounding the extinction of the dinosaurs. Where known, the

stratigraphic position of articulated specimens has been tabulated with respect to the erathem boundary (Table 1). A fragmentary dinosaur tooth has ben collected from about 11 meters below the Ardley coal seam (Russell, 1987). This is the highest stratigraphic occurrence of dinosaur remains in The Scollard Formation as currently known. Because of their unusual faunal composition and their terminal Mesozoic age, any fossil specimens observed should not be collected.

Dinosaurian material from the Cretaceous portion of the Scollard Formation includes:

Order Saurischia

Family Troodontidae

cf. Troodon sp.

Family Ornithomimidae

Undetermined genus

Family Tyrannosauridae

Undetermined genus (small)

Tyrannosaurus rex

Order Ornithischia

Family Iguanodontidae?

Undetermined genus

Family Thescelosauridae

Thescelosaurus neglectus

Family Protoceratopsidae

Leptoceratops gracilis

Family Ceratopsidae

Triceratops albertensis

cf. Torosaurus sp.

Undetermined genus

Family Ankylosauridae

Ankylosaurus magniventris

Family Hadrosauridae

Undetermined genus

Family Pachycephalosauridae

Pachycephalosaurus?

Table I. Position (where known) of articulated specimens relative to Cretaceous-Tertiary boundary (base of Nevis Seam).

Specimen	Position below Nevis Seam (m)
NMC 8861 cf. *Triceratops albertensis*	2.3
NMC 9542 cf. *Triceratops albertensis*	4.5
UA 9542 uncatalogued cf. *Torosaurus* sp.	8.0
TMP 81.12.1 *Tyrannosaurus rex*	10.5
NMC 8862 *Triceratops albertensis*	33.2
NMC 8889 *Leptoceratops gracilis*	33.2
Uncollected large ceratopsian (NMC field records)	34.8
NMC 887, 8888 *Leptoceratops gracilis*	34.8
Uncollected large ceratopsian (NMC field records)	42.4
NMC 8880 *Ankylosaurus magniventris*	43.9
AMNH 5213 *Ankylosaurus magniventris*	45.4
NMC 8537 *Thescelosaurus neglectus*	48.5

A number of other vertebrate types have been described from the formation. Of particular importance was a study by Lillegraven (1969) describing a wide variety of mammals from the Maastrictian portion of the Scollard. These vertebrates include:

Chondrichthyes

Palaeospinax ejuncidus Lambe

Myledaphus bipartitus Cope

Osteichthyes

Acipenser sp.

Kindlea fragosa (Jordon)

Atractosteus sp.

Belonostomus sp.

Amphibia

Scapherpeton tectum Cope

Urodela, undet. gen. and sp.

Anura, undet. gen. and sp.*

Reptilia

Champsosaurus sp.

Crocodilia

Pterosauria

Chelonia

Sauria. cf. *Parasaniwa wyomingensis* Gilmore

Mammalia

Mesodma hensleighi Lillegraven

Mesodma formosa (Marsh)

Mesodma thompsoni Clemens

Cimexomys priscus Lillegraven

Cimolodon nitidus Marsh

Cimolomys gracilis Marsh

Cimolomys trochuus Lillegraven

cf. Deltatheroides cretacicus Gregory and Simpson

Alphadon marshi Simpson

Alphadon wilsoni Lillegraven

Alphadon rhaister Clemens

Pediomys elegans Marsh

Pediomys krejcii Clemens

Pediomys hatcheri (Osborn)

Didelphodon vorax Marsh

Gypsonictops hypoconus Simpson

Gypsonictops illuminatus Lillegraven

Cimolestes cerberoides Lillegraven

Cimolestes propalaeoryctes Lillegraven

Cimolestes magnus Clemens and Russell

Batodon tenuis Marsh

The K-T boundary at the base of the Nevis Coal seam (Coal seam #13), about which much speculation and debate has been focused recently, is precisely placed using palynomorphs and the identification of the iridium spike (Fig. 4). It has also been accurately placed within the magnetic stratigraphic sequence.

Western Canada was entirely terrestrial at the end of the Maastrichtian. Sedimentation indicates a general lack of extensive coal deposits with the sedimentation dominated by fluvial and overbank detritus. The vegetation was dominated by angiosperms. Above the boundary, the sediments show widespread coal swamp development took place with the vegetation apparently dominated by gymnosperms. The exception to this observation is an episode of angiosperm dominance immediately about the K-T boundary followed by a short interval of fern dominance.

The end of the Cretaceous is often thought as being synonomous with the extinction of the dinosaurs. Table 1 gives the position of the known fossils in relation to the boundary. No dinosaur bones, either articulated or inarticulate, have been seen within 2 m of the boundary in the vicinity of this section.

Acknowledgements

This field guide has been prepared utilizing a number of sources. Not all of which are readily available. Previous limited circulation field guides provided inspiration and ideas to the authors. Dale Russell (National Museum of Canada) had earlier published a more detailed account of the dinosaurs of the Scoliard Formation from which the present text was taken. As well, much of the portion of the present text dealing with dinosaurs of the Horseshoe Canyon appeared earlier in a guide and was prepared by Philip Currie (Tyrrell Museum of Palaeontology). Becky Kowalchuk patiently and expertly prepared the final typed version of the guide. Donna Sloan prepared the figures for the guide. To all these individuals we extend our thanks.

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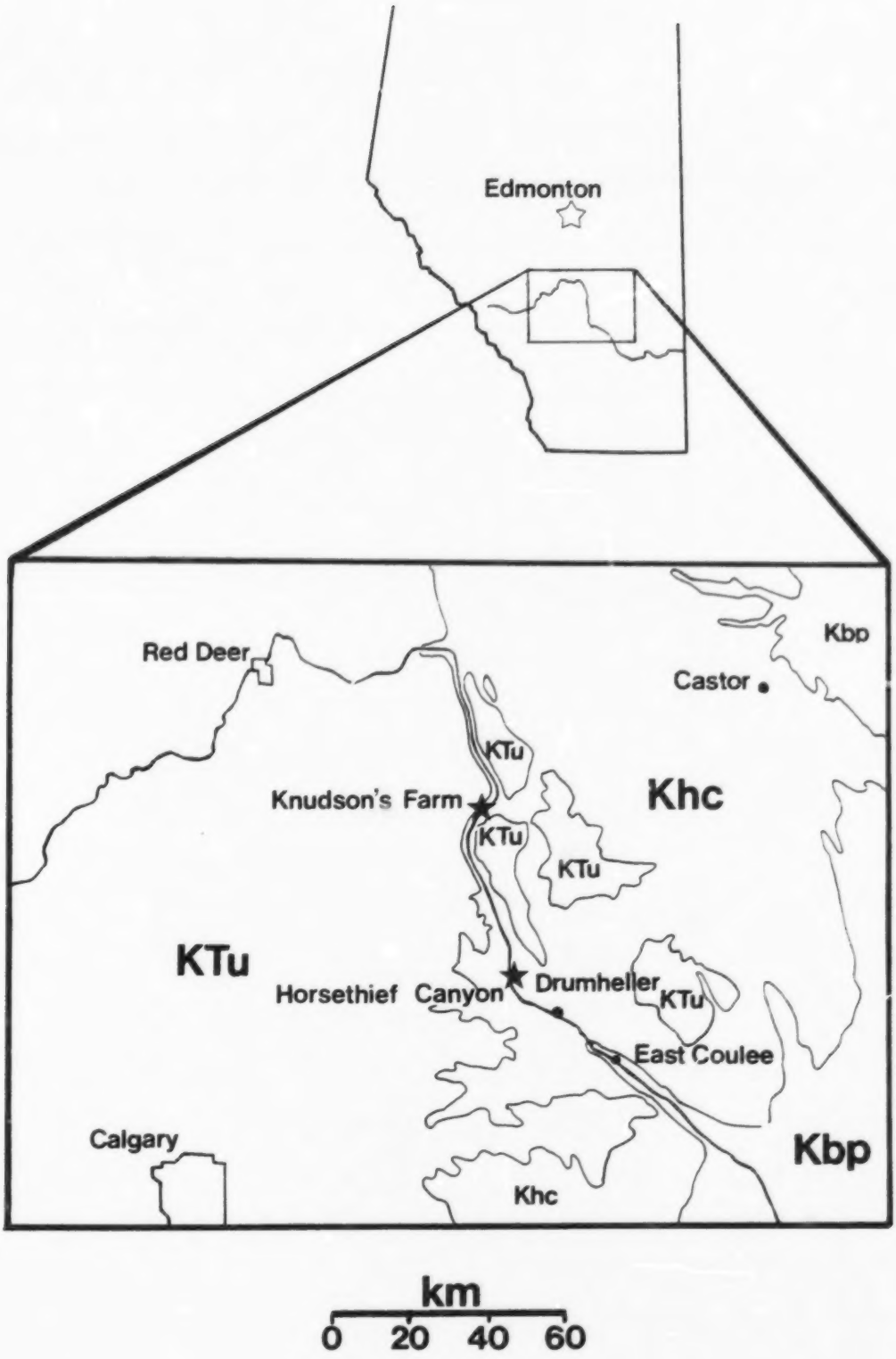

Figure 1: Location of principal field trip stops and general geology of south-central Alberta. Ktu - Whitemud, Battle, Scollard and Paskapoo formations undivided; Khc - Horseshoe Canyon Formation; Kbp - Bearpaw Formation.

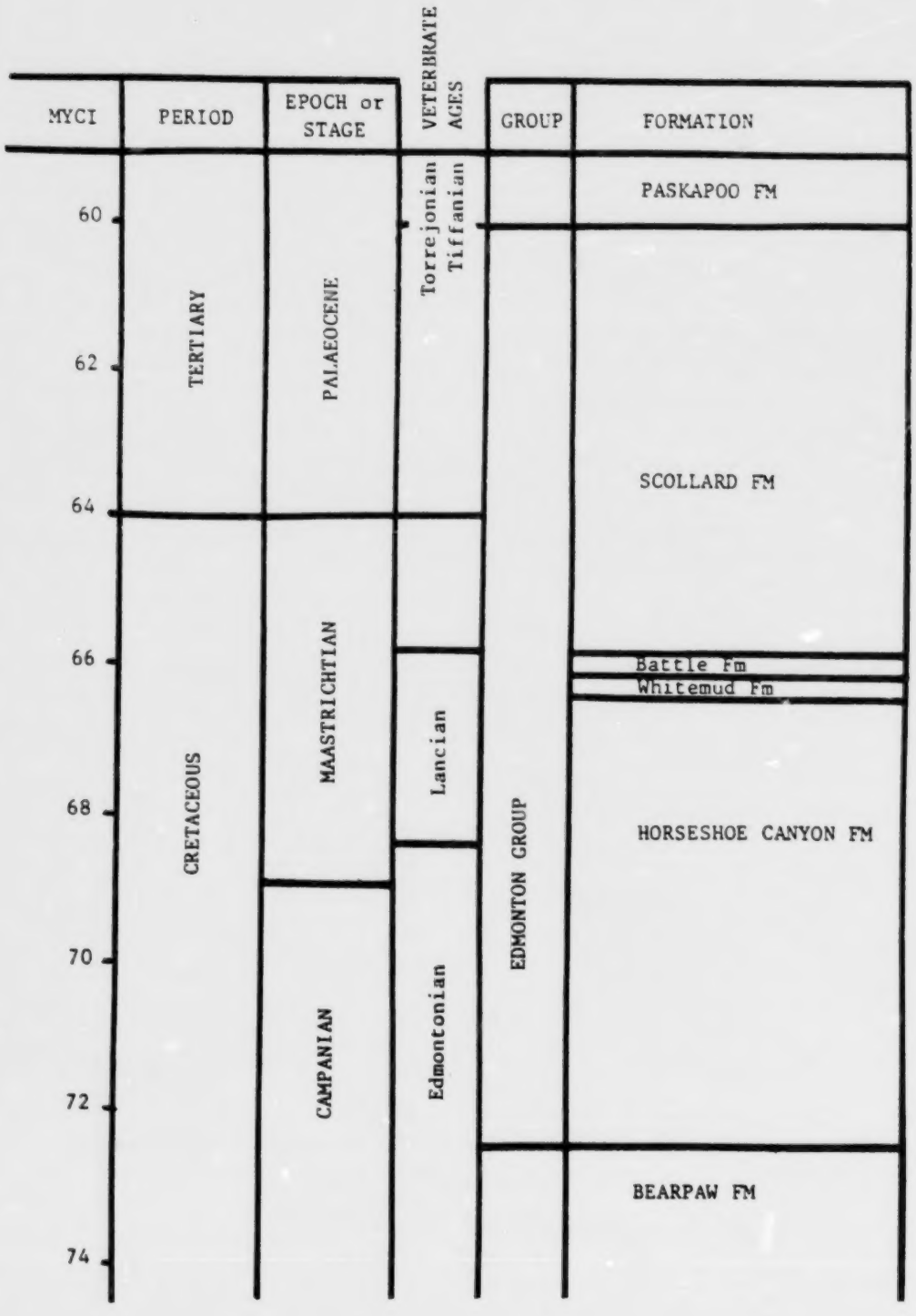

Figure 2: Upper Cretaceous-Lower Tertiary Stratigraphy in the area of the Red Deer River of South-central Alberta.

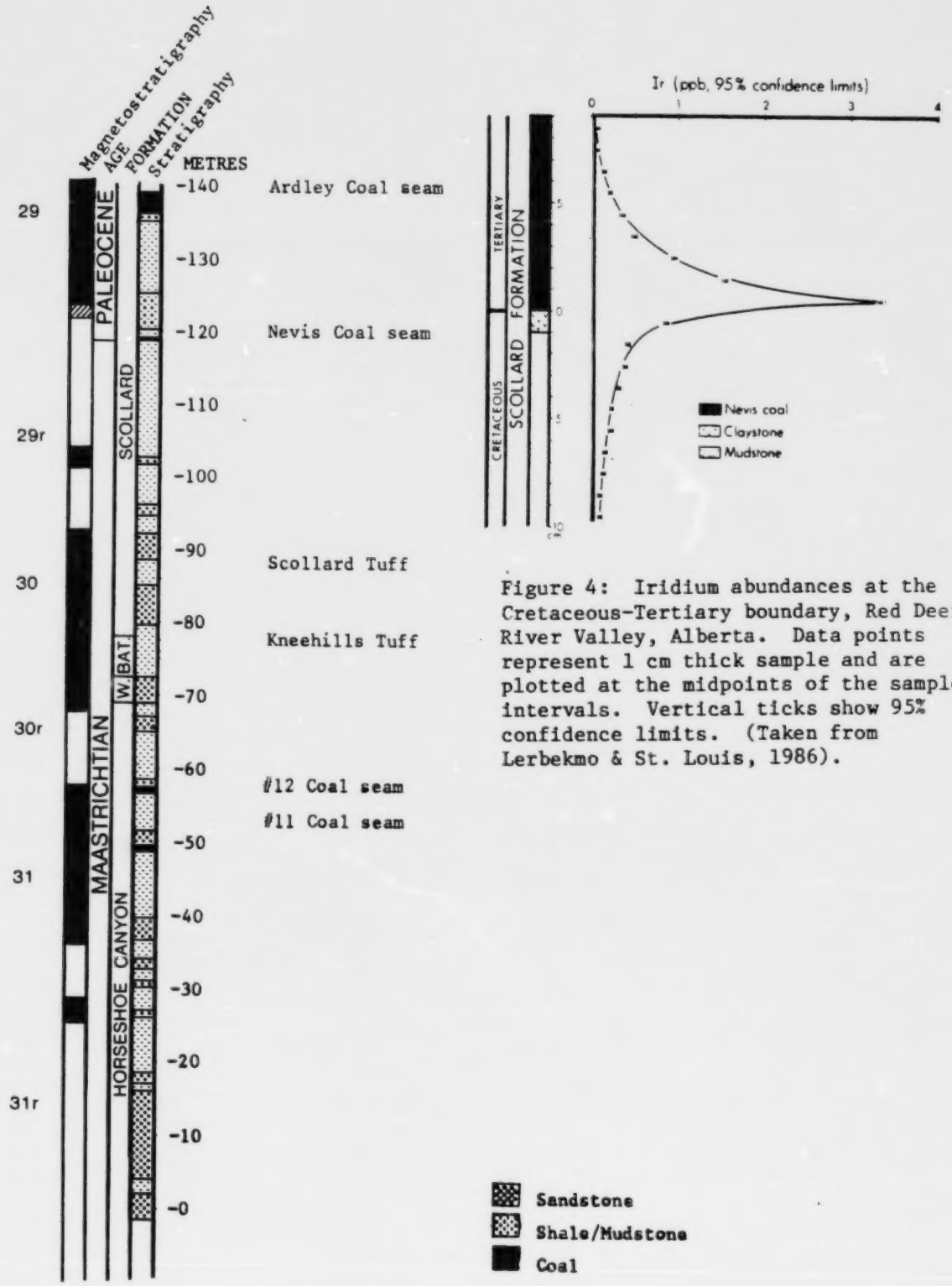

Figure 4: Iridium abundances at the Cretaceous-Tertiary boundary, Red Deer River Valley, Alberta. Data points represent 1 cm thick sample and are plotted at the midpoints of the sample intervals. Vertical ticks show 95% confidence limits. (Taken from Lerbekmo & St. Louis, 1986).

Figure 3: Stratigraphic section as exposed near Knudson's Farm Locality. Data taken from Lerkekmo and Coulter, 1985). W = Whitemud BAT = Battle.